

ON THE STAPEDIAL ANATOMY OF NON-MAMMALIAFORM CYNODONTS

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The stapes is known in several non-mammaliaform cynodonts although it has only been cursorily studied. Here we thoroughly analyze the stapedial anatomy of several basal cynodonts in a phylogenetic framework. Non-mammaliaform cynodonts stapes has two crurae and a stapedial foramen. The fused crurae may extend into medial and/or lateral platforms reducing the stapedial foramen relative size. The presence of straight crurae is the basal condition and the most widespread among non-mammaliaform cynodonts; however, variations of this morphology are recognized in the gomphodonts *Langbergia*, *Trirachodon*, *Exaeretodon*, and some specimens of *Massetognathus*. The anterior crus is more robust than the posterior one in most of the cynodonts analyzed. The opposite situation is registered in *Exaeretodon*, some specimens of *Massetognathus*, *Probainognathus*, and *Morganucodon*. The crurae are subequal in *Scalenodon* and some specimens of *Galesaurus* and *Probainognathus*. A relatively small stapedial foramen is observed in the basal non-mammaliaform cynodonts *Platycraniellus*, *Procynosuchus*, and *Progalesaurus* whereas it is larger in gomphodonts. The stapedial foramen size is highly variable intraspecifically in *Galesaurus* and *Massetognathus*. *Procynosuchus* and *Thrinaxodon* only have a lateral platform, whereas the presence of a single medial platform is synapomorphic of a more derived clade including *Platycraniellus* plus Eucynodontia. *Galesaurus*, *Procynosuchus*, and *Thrinaxodon* share the presence of a lateral ossified portion of the stapes wider than the medial one whereas the opposite situation is synapomorphic of gomphodonts and also observed in *Platycraniellus*. Anterior and/or posterior projections medially and/or laterally are inconsistently present in some of the cynodonts studied. These projections are not related to the insertion of soft tissues as it has been interpreted. Some of the taxa analyzed (*Luangwa*, *Massetognathus*, and *Trirachodon*) bear a delicate flange-like triangular dorsal process on the dorsal surface of the posterior crus pointing dorsally or dorsomedially. Its presence is variable intraspecifically and among closely related taxa. This process cannot be readily homologized with the tympanic process of more basal synapsids. The morphology of the dorsal process is compatible with the insertion of a small ligament or perhaps the stapedial muscle. The presence of a cartilaginous extrastapes contacting a postquadrate eardrum is not supported by the evidence available. The inclusion of characters provided by the stapes in a total evidence data matrix (including cranial, postcranial, and dental characters), showed that they are phylogenetically informative. Our analysis results in a better understanding of the auditory system in basal cynodonts and its evolution, highlighting the variability of the stapedial anatomy, even intraspecifically.

